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Particle number emissions from diesel and CNG buses during acceleration

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Compressed natural gas (CNG) is increasingly being promoted as a cleaner alternative fuel to diesel. While it is known that particle mass emissions from CNG vehicles are much lower than from diesel vehicles (Wang et al, 1997; Jayaratne et al, 2009), there is much uncertainty with respect to the corresponding particle number emissions, especially during transient cycles (Holmen and Qu, 2004), aggressive driving (Clark et al, 1999) and acceleration (Jayaratne et al, 2008).

Particle number emissions from nine diesel and thirteen CNG-powered buses were monitored on a chassis dynamometer at both steady-speed full power and during the DT-80 transient driving cycle. This cycle includes three sharp accelerations from rest to 80 km h^{-1}, followed by a 1 min cruise at this speed. Particle number concentrations were measured with a TSI 3022 condensation particle counter. The sample was drawn from a a continuous flow dilution system using a Dekati ejector-diluter. Particle mass and CO_2 were measured with a TSI DustTrak and Sable CA10 monitor, respectively. The dilution factors were estimated by comparing the measured CO_2 concentrations with that at the tailpipe. All parameters, were measured at 1s intervals. From the dilution factor and the exhaust flow rate, we derived particle number emission rates from both types of buses during the following driving conditions: (1) 80 km h^{-1} cruise (2) steady-speed at full-power and (3) initial full-power acceleration.

Fig 1 shows an initial full-power acceleration segment of a DT-80 cycle. The peak particle number emission rate from the CNG bus was over an order of magnitude greater than from the diesel bus. This was observed consistently in all DT-80 cycles.

Fig 2 compares the mean emission rates for both types of buses during each of the three driving conditions. The emissions from the two types of buses were comparable under steady speed conditions, even at full power. However, during full-power acceleration, the emissions from the CNG buses increased significantly and exceeded the emissions from the diesel buses by over an order of magnitude. No difference was observed in the particle mass emission rates, indicating that most of the excess particle number from the CNG buses was in the nanoparticle size range.

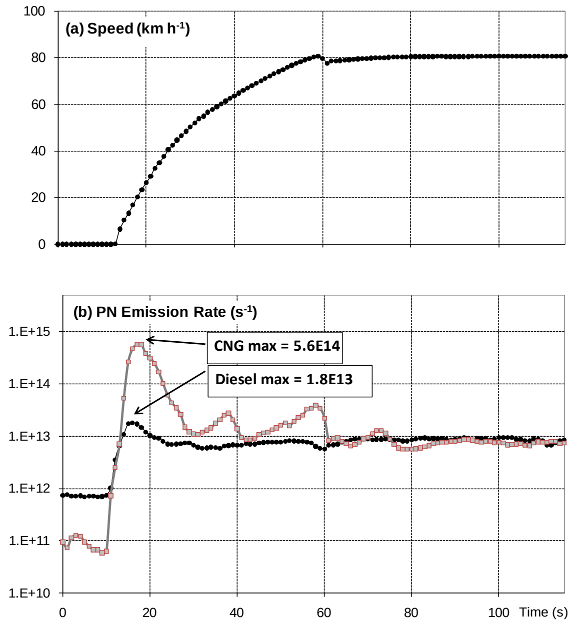

Figure 1: Speed and particle number emission rates from a diesel bus and a CNG bus during an initial full-power acceleration segment of a DT-80 cycle.

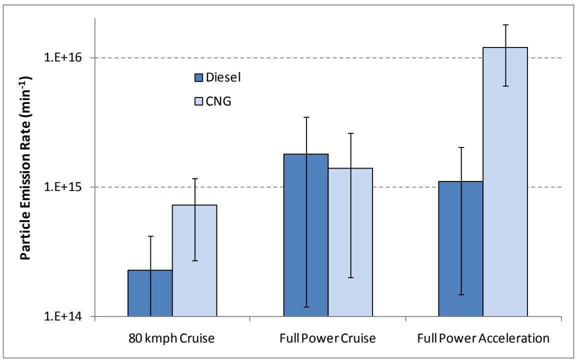

Figure 2: Particle number emission rates for both types of buses during the three driving conditions.

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Holmen and Qu (2004) *Env Sci Tech*. 38, 2413-2423.
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